PB-217 280

TENDENCIES IN STANDARDS OF RIVER AND LAKE CLEANLINESS

H. W. Streeter

Public Health Service
Washington, D. C.

13 June 1934

DISTRIBUTED BY:

NTIS

National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

1- 148 LIBRARY PB 217 2801
ENVIRONMENTAL HEALTH CENTER
CINCINNATI, OHIO

TENDENCIES IN STANDARDS OF RIVER AND LAKE CLEANLINESS

by

H. W. Streeter
Senior Sanitary Engineer
United States Public Health Service.

(Presented at the meeting of the Illinois Association of Sanitary District Trustees, Waukegan, Ill., June 13, 1934.)

During recent years a strong trend has developed throughout the entire field of public health and sanitation toward the formulation of standards, both in respect to administrative practice and in relation to methods of technical control. In public health administration, committees thus have been endeavoring to set up standards of organization, budgeting, disease reporting, and efficiency rating. In general sanitation we find numerous examples of a similar tendency such as the formulation of standards for milk control, for housing and air conditioning, for the sanitation of shellfish areas, and for the quality of public drinking water supplies.

In connection with the general problem of waterways sanitation, the question of standards has occupied the thought of various authorities for many years past. In Great Britain its consideration began as early as 1865, when the first of several legislative acts was passed to permit local authorities to combine to protect watercourses from pollution by sewage. In 1875 these several acts were replaced by the Public Health Act, which was followed by the River Pollution Prevention Acts of 1876 and 1893. Under the former the well-known Mersey and Ribble and West Riding Rivers Boards were organized. In 1898 the second British Royal Commission on Sewage Disposal was appointed, and the subsequent reports of various investigations carried out by this commission have become part of the classic literature of sewage disposal and river sanitation.

Although the congestion of industrial population in Great Britain together with the smallness and shortness of rivers in that country, caused attention to be directed to stream pollution at a somewhat earlier period than in most other countries, the situation in the northeastern section of the United States caused the Massachusetts Board of Health to institute, in 1872, a study of sewage disposal and river pollution in that State. This study led to the notable series of investigations at the Lawrence Experiment Station, with which the names of such pioneer leaders as Drown, Sedgwick, Mills, Fuller, Hazen, Phelps, Clark, and others have been indelibly

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
U S Department of Commerce
Springfield VA 22151

Reproduced from best available copy.

associated. To these men we owe much of the progress which has been made in this country in water and sewage sanitation during the past 30 or 40 years.

The earlier concepts relative to standards of waterways pollution were shaped very materially by the conditions prevailing both in the British Isles and in New England at that time. In both instances the safety of public water supplies was little involved in the question, as these supplies were derived then, as now, very largely from upland sources located in practically uninhabited drainage areas. The major problem to be met was the prevention of the gross degradation of streams which was leading to widespread conditions of nuisance and menace to fish life in numerous important rivers of those areas.

From an exhaustive series of investigations, described in nine separate reports with appendices, the British Royal Commission formulated two sets of standards. One dealt with limiting specifications for composition of various trade-waste effluents, including those of coal washing, tin, lead, and zinc mining, paper making, brewing, oil distillation, wool scouring, and tanning. The other was concerned with the quality of sewage effluents, its more significant provisions being, in brief, that an effluent should not contain more than 30 parts per million of suspended matter and should have a 5-day B.O.D. (at 65° F.) not exceeding 20 parts per million. With various degrees of dilution in the receiving watercourse, ranging from 150 to over 500 volumes of water, this requirement was modified so as to permit as high as 150 parts per million of suspended matter in the effluent with dilutions up to 500 volumes.

As the basis of this standard, the commission formulated a working rule derived from an extensive survey of actual conditions, that the 5-day B.O.D. of a stream water polluted by a sewage effluent should not exceed 4 parts per million in order to maintain satisfactory conditions in the stream at a mean summer temperature of 65° F. and under dry-weather flow conditions. In formulating these requirements, the commission was influenced very materially by a general dictum, enunciated in 1878, that no river in England is long enough to purify itself completely.

In the United States, the first systematic effort to formulate a standard of pollution for rivers was that of Dr. Hering, who, in 1887, in reviewing evidence concerning the necessary dilution required for Chicago sewage in the Chicago Drainage Canal, concluded that the dilution provided should be at least 150 to 200 cubic feet of minimum stream flow per minute for each 1,000 persons discharging sewage into the stream. This led to the adoption of a minimum dilution of 3.3 cubic feet per second per 1,000 population.

Shortly after the formulation of the Hering dilution standard, Stearns, in a report to the Massachusetts Board of Health issued in 1890, introduced the custom of estimating the amount of various constituents added to sewage by each inhabitant daily and then estimating what these constituents would be in the stream with dilutions ordinarily found in streams of varying degrees of pollution. Although no definite conclusion was drawn, he stated that the debatable limit of dilution would fall somewhere between 2.5 and 7.0 cubic feet per second per 1,000 population. In his Ohio report of 1898, Hazen introduced the qualification that in sluggish streams, or in streams already somewhat polluted, the proper dilution might be increased to 6.8 or 10 cubic feet per second per 1,000 persons. In 1902, Goodnough concluded from his surveys in Massachusetts that objectionable conditions were found in all cases where the dilution was less than 3.5 second-feet per 1,000 persons, but were not likely to be objectionable where the dilution exceeded about 6 second-feet.

As previously noted, these various dilution ratio standards, as well as that which the British Royal Commission formulated for sewage effluents, were based very largely on observations made in relatively small and short streams, where natural purification was not a very powerful influence, and they were concerned primarily with the prevention of conditions which would be termed as offensive, rather than with maintaining the safety of public water supplies, which was not materially involved in these situations.

During the past 25 years or thereabouts, the public health aspects of river and lake pollution have been receiving more attention, both in this country and abroad, as the result of a growing public consciousness of this phase of the problem. At the present writing a fairly clear distinction is being made by sanitary authorities between water pollution directly or indirectly affecting the public health and that which is concerned primarily with economic rather than health values, though in some cases the two interests are so intimately related that a sharp line of distinction can hardly be drawn between them. On this basis we may attempt a rough classification of water pollution problems as they now exist in this country and then consider briefly the present trend of thought relative to standards of pollution under each respective class.

The main items of such a classification might be stated somewhat as follows:

I. Pollution not affecting directly the public health.
   A. That which gives rise to conditions commonly included under the general term "nuisance", or which, though not causing actual "nuisance", may tend to damage the value of bordering property for residential, agricultural, or recreational uses.

B. That which affects the maintenance of fish life in streams and lakes and the use of such water for recreational purposes.

C. That which may cause tastes, odors, or other undesirable qualities in public water supplies.

II. Pollution affecting the public health.

A. Excessive pollution of sources of public water supply, either by sewage or by toxic industrial wastes.

B. Pollution of edible shellfish-growing areas by sewage and industrial wastes.

C. Pollution of water areas used for bathing purposes.

Let us now consider some of the present tendencies in reference to standards of pollution under these headings.

STANDARDS OF POLLUTION NOT DIRECTLY AFFECTING PUBLIC HEALTH INTERESTS

The general tendency in fixing limits of pollution of waterways not used as sources of public water supply, or for shellfish culture, or for bathing purposes, has been, in this country at least, to specify a minimum permissible dissolved oxygen content of such waters under summer, low-water conditions, or to set some requirement as to a favorable balance between oxygen demand and oxygen supply.

For "nuisance" prevention, the limiting minimum dissolved oxygen content has been variously stated, ranging from as low as 25 or 35 percent to as high as 70 percent of the oxygen saturation value. In a recent report on the disposal of sewage in the Potomac River, Grunsky* notes that certain investigations in the Thames River below London and in the Delaware River at Philadelphia have indicated that, under conditions there existing, the dissolved oxygen in the supernatant stream could be as low as 10 or 20 percent without causing odors in the vicinity of the point of low oxygen content. On the other hand, a minimum D.O. as high as 70 percent of saturation was recommended by Black and Phelps** as being desirable for New York Harbor, though other observers suggested later that this figure

---

* Disposal of sewage in the Potomac River, United States, 72d Cong., 2d sess., Senate Document No.172.

** Black, W.M., and Phelps, E.B.; Discharge of sewage into New York Harbor. Report to New York City Board of Estimate and Apportionment. 1911.

might be lowered safely to 25 or 35 percent, provided that sludge deposits could be kept under control. In the recent report of the Tri-State Treaty Commission of New York, New Jersey, and Connecticut, on measures for abating pollution of the harbor and coastal waters of the metropolitan area, the minimum dissolved oxygen recommended for class B areas, not used for bathing or shellfish culture, has been 30 percent of saturation, with the added requirement that not less than 10 percent of the suspended solids should be removed from the wastes discharged into these areas.

In several recent cases, as in the case of the Illinois River, a standard of pollution based on maintaining a positive oxygen "balance", or excess of available oxygen supply over oxygen demand, has been recommended. This viewpoint is somewhat like that underlying the British Royal Commission standard, which, as previously noted, was based on the principle of maintaining a 5-day B.O.D. in the stream water not exceeding 4 parts per million, a fairly safe margin for obtaining a positive oxygen balance.

For supporting fish life in streams and lakes, minimum oxygen standards are in general most widely favored in the United States, though the validity of this and other single criteria has been recently attacked by Hubbs,* an expert in fisheries research, who points out that some conditions deleterious to fish are not reflected either by dissolved oxygen or by oxygen demand values in a stream water. Opinions as to the minimum amount of dissolved oxygen in a natural body of water necessary to support ordinary fish life have varied, some observers placing it as low as 2.5 parts per million, and others as high as 4.0 parts per million. Recent practice, however, has favored 3.0 or 4.0 parts per million as being desirable, when considered as an average minimum, and the present trend is toward even higher concentrations where the maintenance of all normal forms of fish life is involved.

In this connection Hubbs notes the "minnow test", as used in New York, and the reserve oxygen criterion, in which an excess of dissolved oxygen over oxygen demand amounting to upwards of 3 parts per million is specified. Although he regards the "minnow test" as unreliable, because of the variation of different species of minnows in their viability, he considers the "reserve oxygen" type of standard as being a step in the right direction, as compared with the simple minimum dissolved oxygen requirement. He points out, however, that the application of standards of this kind on the basis of average observations may be misleading, citing as an example an instance in which, owing to algae growths, the observed dissolved oxygen content during sunny daylight hours ran as high as 200 percent saturation, but during the night, and especially in the early morning

---

* Hubbs, C.L.; Sewage Treatment and Fish Life. Sewage Works Journal 5, 1933, 1033-40.

it became practically exhausted. Under such conditions numerous fish could be killed during a comparatively short period of oxygen depletion. Sewage sludge deposits are considered by Hubbs as being particularly detrimental to fish life, as they interfere with the normal spawning process.

The presence of undesirable tastes and odors in water supplies and means for correcting them have engaged the attention of sanitary chemists and biologists for many years. More recently, this problem has become one of primary importance, owing to the extreme sensitiveness of the consuming public to the aesthetic properties of their drinking water and to the increasing difficulties experienced in removing tastes and odors from water supplies derived from highly polluted sources. In some instances, as where phenols and cresols are present, treatment may only serve to intensify these disagreeable effects. In others, as where the products of organic decay are present, the resulting tastes and especially odors may be very difficult to remove once they have become established.

Although no definite standards have been adopted in these cases, a systematic effort is being made in several States to eliminate known sources of pollution by taste-producing substances. Phenol-bearing wastes have been a special point of attack in this connection, as it is now recognized that the only certain way to prevent tastes originating in wastes of this character is to divert them entirely from streams and lakes used as sources of water supply. A basis for more accurate measurement of tastes and odors in water supplies has been recently established through the work of Spaulding and Baylis in Illinois and that of Fair and his associates at Harvard University. With such improved tests now available, a more precise definition of taste and odor standards and their application is possible.

In some sections of the United States pollution of sources of public water supply by certain mineral substances has an important bearing on the general suitability of these supplies for domestic and industrial use, entirely aside from its possible effects on the public health. In the oil field areas of the southwestern States, for example, the increasing contamination of both surface and ground waters by sodium chloride, or common salt, originating in brines associated with oil deposits, has given rise to a problem of growing seriousness as affecting the general suitability of water supplies derived from these sources, as no practicable method of water treatment can remove this constituent. In some of the western States pollution of water supplies by sodium salts and other hardness-bearing minerals has resulted in another problem of similar import. In the coal-mining regions of Pennsylvania and West Virginia the leaching of acid mine-wastes into surface streams has impaired the suitability of both industrial and domestic water supplies in these

sections. These are only a few of numerous instances of mineral pollution, largely due to the intensive operation of certain industries which, if not curbed, may conceivably result ultimately in making some portions of these areas almost uninhabitable by large aggregations of population.

In promulgating a revised official standard of quality for drinking water supplies furnished to the traveling public by the interstate carriers, the United States Treasury Department, acting through an advisory board of the Public Health Service, included in the standard a specification as to the limiting permissible concentrations of certain mineral salts producing undesirable tastes and hardness in such waters. Among these salts, chlorides and sulphates are limited each to 250 parts per million, magnesium to 100 parts per million, and carbonates of sodium and potassium to 50 parts per million. It is of interest to note in this connection that an important city in the southwestern part of the United States recently was obliged to discard consideration of a nearby surface source of water supply, though ample in quantity, because the chloride content of water obtainable from this source was found to be in excess of the limit fixed by the Treasury Department standard.

STANDARDS OF POLLUTION AFFECTING PUBLIC HEALTH

It has been previously noted in this paper that the three main effects of river and lake pollution in the United States related to the public health are those which have to do with the safety of (1) public water supplies, (2) shellfish growing areas, and (3) public bathing places. Before taking up the most important of these, which is, of course, the effect on public water supplies, let us consider the two others in the order named.

In the year 1925, following outbreaks of typhoid fever in various cities of the United States in 1924, definitely traced to infections received from eating contaminated oysters, the Federal Government, through the Public Health Service, established in cooperation with the States a system for controlling the sanitation of the shellfish industry, including the water areas used for growing purposes. In this connection, a tentative standard was suggested for limiting bacterial pollution of the waters in which shellfish were grown, this standard providing that the waters should ordinarily not show the presence of B. coli in 1 cc amounts, tests being made in 10, 1.0, and 0.1 cc volumes according to the Standard Methods of the American Public Health Association. A modification of this standard, which, in effect, limited the B. coli index of these waters to 10 per 100 cc, was later suggested, permitting the waters to show

B. coli in 50 percent or less of the 1 cc amounts tested. The effect of this modification was to fix a maximum B. coli index of 50 per 100 cc for ruling out waters from market shellfish growing. This standard is now applied in a number of States cooperating in shellfish sanitation.

Under the leadership of Gage, a joint committee of the American Public Health Association and the Conference of State Sanitary Engineers issued, in 1926 and 1928, reports suggesting comprehensive standards for the sanitation of bathing pools. In 1932 the committee, under the chairmanship of Scott, extended the scope of its activities to considering standards for outdoor bathing places, including those located in natural bodies of water. In its 1932 report the committee notes existing practice in certain States relative to bacterial standards of pollution for natural waters used for bathing purposes.

According to their report, the proposed standard in California limits the B. coli index of these waters to 1,000 per 100 cc. In New York City a limiting standard of 3,000 per 100 cc is used. From a study of Connecticut waters, Winslow and Moxon have suggested that possibly an average of not over 100 B. coli per 100 cc with a maximum not over 1,000 might be a reasonable figure for such a standard. The Connecticut State Department of Health recently completed an extensive survey of shore bathing waters in that State, from which the following classification of these waters was made on the basis of their average B. coli content:

Class	Average B. coli index per 100 cc	Percentage of shore mileage
A	0-50	64.0
B	51-500	18.6
C	501-1,000	10.2
D	Over 1,000	7.2

Class A was considered good; class D was very poor, with the two intermediate classes ranging from doubtful to poor. It is of interest to note that there was exact correlation of the analysis and sanitary survey in 62 percent of the total areas and that an additional 37 percent showed a difference of only one class, leaving only 1 percent of the total area where the analytical results did not check up with the sanitary survey data.

If the Connecticut classification were applied to the other standards above noted, the New York City standard would admit all four classes from A to D; the California standard would admit all but class D, and the Winslow-Moxon, classes A and B. The United States Public Health Service's tentative shellfish water standard of 50 B. coli index per 100 cc would admit class A only. The committee recommends adoption of the Connecticut classification as the basis of further study, which it feels should be given especially to defining the proper status of classes B and C .

The question of pollution standards for water areas used for recreational purposes has been closely related to that of bathing water standards. The Tri-State Pollution Commission, previously mentioned in thispaper, has dealt with this question by including recreational water areas in class A in its scheme of classifying those of the metropolitan district surrounding New York City. For this class, all sewage discharged into such waters must be treated so as to remove all floating solids and at least 60 percent of the suspended matter, and to effect a reduction in B. coli organisms consistent with the requirement for class A waters in the Connecticut scheme (i.e., having a B. coli index not exceeding 50 per 100 cc).

It thus appears that for the better class of water areas devoted to shellfish culture, to public bathing, or to recreational uses, a distinct tendency now exists to work towards a bacterial standard represented by a limiting B. coli index approximating 50 per 100 cc. It is of interest to note that this single standard has been reached by separate agencies working on three different kinds of water-use problems. It will be shown presently that this standard also practically coincides with what has been determined as the upper limit of bacterial pollution of raw waters subjected to chlorination alone, for public water supplies, which will be the next and final aspect of this subject to be considered here.

The history of efforts to formulate standards of pollution for sources of public water supplies is comparatively recent, extending back only to the year 1914, when the International Joint Commission of Canada and the United States adopted as a standard of this kind the rule that the yearly average B. coli index of sources of water supply located in the international boundary waters between the two countries should not exceed 500 per 100 cc. This standard was based on the joint opinion of a board of expert sanitary engineers employed by the commission, who formulated it on the assumption that all public water supplies derived from the boundary waters should be purified to such an extent that their B. coli content would not exceed the limit imposed by the original Treasury Department official water standard (i.e., a B. coli index of 2 per 100 cc).

Shortly after the International Joint Commission standard was recommended, the United States Public Health Service, in connection with its investigation of stream and lake pollution, began a comprehensive field and experimental study of the efficiency and limitations of current water-purification systems under conditions of practical operation, with a view to establishing, if possible, an empirical basis of formulating standards for various general types of raw-water sources, combinations of water treatment, and desired qualities of final effluent, the latter being in anticipation of further revisions of drinking-water standards, such as that of the Treasury Department, which might be made from time to time. During the progress of that study, the Treasury Department water standard was revised (in 1925) so as to provide, in effect, that the average B . coli index of drinking water served by the interstate carriers should not exceed 1.0 per 100 cc, with a permissible range of variation up to 6.0 per 100 cc in not more than 5 percent of the samples examined.

The results of that study, which have been published from time to time, have indicated that, for the average efficient modern water-filtration plant of the usual rapid sand type, with postchlorination included, the maximum raw water B. coli index yielding a final effluent conforming to the revised Treasury Department B. coli standard will approximate 5,000 per 100 cc, as a round number, for all classes of water sources considered, including the Great Lakes and rivers of the general type found in the Great Mississippi Basin.

If a single limiting standard of pollution for both river and lake sources of purified water supplies in this general area were to be recommended from the results of the Public Health Service study, a rounded B. coli maximum of 5,000 per 100 cc, expressed in terms of the Phelps index, or a corresponding maximum of about 9,000 per 100 cc when expressed in terms of the "most probable number", would appear to be the most rational basis available for such a standard, for the following two reasons: (1) It represents, within the range of expected error, the limiting content of raw water B. coli organisms observed for each group of filtration plants studied, as being consistent with the production of final effluents meeting the current Treasury Department drinking-water standard, and (2) it marks approximately the critical average density of raw water pollution above which difficulties in effective treatment and in obtaining palatable and otherwise satisfactory effluents for domestic use have been observed quite consistently as beginning to appear.

In applying a standard of this kind, due account would have to be taken of the fact that the B. coli density above stated is a limiting maximum, rather than a limiting average, and that a raw water having a yearly average B. coli index of 5,000 or thereabouts

might show a considerable excess of B. coli content over this amount for a significantly large proportion of the time. For this reason it might be necessary, in formulating it, to use a working factor of safety, either by scaling down the permissible limit below 5,000, as a yearly average, or by requiring an average quality of final effluent somewhat better than that which is represented by the B. coli limit fixed by the present Treasury Department standard (which, in fact, would have the same effect). On the other hand, it is entirely possible that some form of supplementary water treatment, such as prechlorination, preliminary storage, or prolonged sedimentation, might provide a sufficiently ample working margin of safety in individual cases to cover adequately all ordinary variations in raw-water pollution above a yearly average limit expressed by a B. coli index of 5,000. Should the matter of adopting a definite standard of bacterial pollution for sources of purified municipal water supplies become one of primary importance from an official public-health standpoint, as is entirely within the range of possibility during the next few years, this question doubtless would receive careful consideration.

Where conditions are such that the only form of water treatment practicable is simple chlorination, the Public Health Service study has indicated that a safe bacterial limit of raw water pollution for all classes of waters considered would be represented by a B. coli index approximating 50 per 100 cc*, which, it may be noted, is the same as that which has been adopted as the upper limit of pollution of waters used for shellfish-growing and for public bathing.

Before concluding this paper, a few statements may be added concerning the relation of standards of chemical pollution to the safety of public water supplies. These chemical standards are becoming more important with the growing recognition of the harmful effects which wastes from certain industries are having on the hygienic quality of public water supplies. Although the present Treasury Department water standard fixes a definite limit to the content of certain metals, such as lead and copper, which have been more or less definitely associated with poisonous effects produced on consumers of water containing them, other toxic substances have become matters for serious concern in water supplies during the past few years since

---

* This rounded figure has been obtained by averaging 3 separate maxima, 30,50, and 80 per 100 cc, derived from 3 independent series of observations. The first was obtained from experimental observations on the purification of Ohio River water (see Public Works, Dec. 1933, pp.17-20), and the second and third, from combined performance data for 2 large groups of municipal filtration plants located, respectively, along the Ohio River and the Great Lakes (see Public Health Reports, Apr. 14,1933, pp.377-400; Reprint 1565, pp. 20). As all 3 maxima fall within a common range of expected observational error, their mean is a fairly representative average for all conditions embraced by the combined results.

the present Treasury Department standard was promulgated. Among these are phenols and cresols, together with their chlorine derivatives, fluorine and fluorides, barium salts, and also cyanides, which recent British studies have shown to have been responsible for killing many young fish in the River Tees. With the present tendency toward using barium salts in connection with water-softening operations, a close watch must be maintained over the use of this chemical, which is known to be toxic to human beings in small concentrations. It may be earnestly hoped that action will be taken in the not distant future to define the safe physiological limits of these various toxic substances in public drinking water supplies and to incorporate them into standards which may be adopted for such supplies in the future.

In conclusion, the present situation with reference to standards of river and lake pollution may be summed up very briefly as follows: The older standards, based on fixed dilution ratios, are being superseded by more definite specifications of certain indicators of relative cleanliness, such as bacterial content, dissolved oxygen, oxygen demand, and known toxic chemical substances. Where the public health is involved, limiting standards of bacterial quality, notably with respect to the density of organisms of the B. coli group, are becoming of primary importance, though in some instances limitation of chemically toxic substances is almost equally significant. At the present writing a reasonably firm empirical basis exists for the formulation of working standards of pollution for practically all waterways in this country used as sources of public water supply. This should be done in the near future, so as to coordinate efforts in the various States toward a rational and uniform policy in dealing with this problem, especially in its interstate aspects.

A fairly good basis also now exists for the formulation of tentative standards of pollution for shellfish-growing areas and for natural bodies of water utilized for public bathing. In the latter case, however, caution will be necessary in attempting to meet a bathing-water standard in some natural waterways subject to non-controllable pollution by surface drainage water and storm sewage. In some of these instances, at least, the extent of dilution provided would not be sufficient to permit conforming to such a comparatively rigid standard, even if the effect of all of the dry-weather sewage entering the water-way were to be removed through adequate treatment.

Where the public health is not involved, the minimum dissolved oxygen standard appears to be the most simple and readily applied one for general application, though a distinct trend toward oxygen "balance" criteria is apparent. Some question remains as to just

where the minimum oxygen level should be placed in specific cases, with a strong tendency to fix it at not lower than 3 or 4 parts per million and at even higher concentrations in some cases. As organic sludge deposits are particularly harmful to fish life and tend to exert a disproportionately heavy oxygen demand on overlying bodies of water, a definite need exists for standards of sewage- and industrial-wastes treatment adequately stringent to result in practically eliminating these deposits from all streams and lakes.

On the part of the general public, there is a growing consciousness of the dangers and economic losses inherent in the excessive pollution of our waterways by sewage and industrial wastes. With the increase in leisure for all classes of our population and the consequently wider opportunities open to everyone for the enjoyment of streams and lakes for various forms of recreation, this consciousness will become more acute and wide-spread during the next few years. This tendency points toward more specific and increasingly rigid standards of cleanliness for all public bodies of water, which are the natural heritage of our people. The old cry of "laissez faire" is out of date in this as in other fields of civilized human life, and the present trend of thought and action carry both a warning and an opportunity to those who are qualified to exert leadership in formulating and putting into effect adequate standards of this kind. As to such standards, it might be well said by way of caution: Let us devise them, try them, revise them, and apply them, but also remember that they are but "feeble instruments of human will" and, like all such tools, are made to be discarded for better ones when they become worn out.

- - - - - - - - - - - - -